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Metrics to assess injury prevention programs for young workers in high-risk occupations: a scoping review of the literature

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Abstract

Introduction: Despite legal protections for young workers in Canada, youth aged 15–24 are at high risk of traumatic occupational injury. While many injury prevention initiatives targeting young workers exist, the challenge faced by youth advocates and employers is deciding what aspect(s) of prevention will be the most effective focus for their efforts. A review of the academic and grey literatures was undertaken to compile the metrics—both the indicators being evaluated and the methods of measurement—commonly used to assess injury prevention programs for young workers. Metrics are standards of measurement through which efficiency, performance, progress, or quality of a plan, process, or product can be assessed.

Methods: A PICO (population, intervention, comparison, outcome) framework was used to develop search terms. Medline, PubMed, OVID, EMBASE, CCOHS, PsychINFO, CINAHL, NIOSHTIC, Google Scholar and the grey literature were searched for articles in English, published between 1975–2015. Two independent reviewers screened the resulting list and categorized the metrics in three domains of injury prevention: Education, Environment and Enforcement.

Results: Of 174 acquired articles meeting the inclusion criteria, 21 both described and assessed an intervention. Half were educational in nature ($N = 11$). Commonly assessed metrics included: knowledge, perceptions, self-reported behaviours or intentions, hazardous exposures, injury claims, and injury counts. One study outlined a method for developing metrics to predict injury rates.

Conclusion: Metrics specific to the evaluation of young worker injury prevention programs are needed, as current metrics are insufficient to predict reduced injuries following program implementation. One study, which the review brought to light, could be an appropriate model for future research to develop valid leading metrics specific to young workers, and then apply these metrics to injury prevention programs for youth.

Keywords: young workers, occupational injuries, injury indicators, occupational health and safety

Introduction

Youth aged 15–24 years comprise approximately 14% of the working population in Canada.¹ Over 2.4 million youth report being employed every year, representing 54% of their age group.^{2,3} Moreover, young workers are at higher risk of occupational injury than older age groups.⁴ Between 2011 and 2013, nearly 93,000 Canadian youth suffered an occupational injury requiring time off from work.⁵

Many governments recognize the need for special measures to protect young workers and, thus, regulate the conditions under which youth are employed. The Government of Canada deems certain types of work to be inherently “high-risk”—in other words, likely to be detrimental in some way to a young person’s health, safety or development. Therefore, youth under age 17 are prohibited from engaging in these occupations, although older youth can work in high-risk settings

Highlights

- Young workers aged 15–24 years are at higher risk of injury than other age groups, requiring additional protections to address social, developmental, cultural and environmental contributors to vulnerability.
- Workplace safety initiatives targeted to young workers can be categorized within three domains of injury prevention: education, environment and enforcement.
- Metrics are required to appropriately assess the effectiveness of young worker injury prevention programs by predicting injuries before they happen.
- This review compiles metrics commonly used to assess young worker injury prevention programs, highlighting a need for more robust metrics which are specific to young workers to develop evidence-based programs.

if provincial or territorial laws permit.^{6,7} Despite such legal protections, a recent study found that young workers under age 17 experienced serious injuries such as: burns, eye injuries, crushing injuries, amputations and electrocutions at a higher rate than their non-working peers.⁸ Furthermore, many of these injuries occurred in trades, primary industry and service jobs.⁸ High injury rates make young workers a unique health and safety concern, particularly in these high-risk occupations.

Workers aged 15–24 years are vulnerable to injury in the workplace in part because they are inexperienced.⁹ Simply being new

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to the workplace may pose a threat to health and safety, because inexperienced workers are unfamiliar with the environment and often lack sufficient job training.¹⁰ Many youth are not aware of their legal rights and are, thus, ill-equipped to request training to appropriately identify and manage potential hazards.¹⁰ Youth may also feel intimidated in the workplace. They may feel powerless to change their working conditions, or may be too shy to voice their concerns.¹¹

Other common factors that put young workers at higher risk for injury are associated with their role within the workplace culture. Young workers are often part-time, seasonal or temporary employees, which can lead to a fragmented safety culture and gaps in training. Such circumstances influence the occupational health perceptions of young workers and its relevance to them. Many have a "it's part of the job" mentality in which they consider minor injuries, such as burns, cuts or scrapes, to be normal and acceptable since they occur often and are not severe.¹² In addition, young workers may not report an injury because of concerns about eliciting a negative reaction from others and potentially jeopardizing their position.¹² The unique vulnerability of young workers is a multi-faceted issue: social, developmental, cultural and environmental factors all contribute.

While many injury prevention initiatives targeting young workers exist, the challenge faced by youth advocates and employers is deciding which prevention aspect(s) will be the most effective focus for their efforts. Injury prevention initiatives can often be categorized within three domains: environment, enforcement and education. Altering the environment can protect young workers by removing physical hazards, while enforcing safety policies can support a protective workplace culture. Education is the third and most popular approach to injury prevention, as it can often be cost effective, implemented rapidly, and broad in scope. However, education is often not sufficient to generate behavioural change; other barriers and motivators to change must be addressed through the other two domains. The best approach is likely a combination of education, environment and enforcement efforts applied in such a way that each supports and reinforces the others.¹³

The benefits of a well-designed safety program are largely corroborated by the absence of injuries, which is difficult to measure in advance. In each domain of injury prevention, it is desirable to develop metrics that can be used to predict injuries before they happen, thus making the assessment of an intervention possible without the necessity of waiting for an injury to occur. This scoping review will address occupational health and safety issues specific to young workers by outlining and categorizing metrics commonly used to assess youth injury prevention initiatives. Effectiveness in preventing injuries is enhanced when young worker programs are appropriately measured and assessed. Furthermore, the harmonization of occupational health and safety standards across jurisdictions is facilitated when common metrics are broadly adopted.

The specific objectives of this scoping review are:

- To identify the metrics currently used to measure the impact of young worker injury prevention programs or workplace safety initiatives;
- To categorize these metrics into three commonly-used domains of injury prevention: education, environment and enforcement¹³;
- To summarize the main considerations emerging in each domain and identify gaps for future research.

Methods

Inclusion criteria

Both published and unpublished peer-reviewed studies of any type, as well as reports or other articles, were considered for this scoping review if they: 1) included young workers under age 25 in the study population, 2) addressed some aspect of occupational injuries, and 3) were relevant to workplaces regulated by the Federal Government of Canada.⁷

Search strategy

Specific search criteria were constantly developed in consultation with two university librarians and the research team. The search included, but was not limited to, terms describing youth injury or fatality at work. The final search strategy is presented in Table 1. One reviewer searched

the following databases for articles in English, published between 1975-2015: Medline, PubMed, OVID, EMBASE, CCOHS, PsychINFO, CINAHL, NIOSHTIC and Google Scholar.

Study identification and selection

The resulting list underwent three screening phases. In the first phase, articles were subjected to a title and abstract screening for the inclusion criteria. If these criteria were not apparent in the title or abstract, the methods section was reviewed. During the second phase, two independent reviewers screened and categorized the articles according to the primary focus of each article: "education", "environment", "enforcement" or "general" (those which did not fit specifically into one of the first three categories). Duplicates were removed, and discrepancies were discussed between reviewers until consensus was reached. During the final phase, articles were reviewed in-depth and further classified according to whether they described the epidemiology of worker injuries, some aspect of risk assessment, or an intervention.

Data abstraction and analysis

Article data was transcribed to a summary table and metrics were abstracted according to what was being measured (outcome) and how the measurement was taken (method). In cases where both definitions applied to the metric, the source of the data was considered as the method. For example, "number of injury deaths" was a common metric; in this case "deaths" was considered the outcome and "coroner reports" or "hospital records" the method. Articles that both described and assessed an intervention were selected for discussion and thematic analysis by considering the relevant occupational setting, main findings, highlights in the discussion section, limitations or recommendations of each study, as well as those within the focus of each domain group.

Results

One hundred and seventy-four articles about occupational injuries applied to young workers. Figure 1 shows the process through which the results were categorized. Overall, 84% of articles were primarily concerned with describing the worker's characteristics and the injury incident. Many focused on injuries that

TABLE 1
Search terms within final PICO framework

P = Injury	I = Intervention	C1 = Age	C2 = Workplace	O = Outcome
injury	data collection	young adult	workplace	guideline
"wounds and injuries"	focus groups	adolescent	workplace"	legislation
wound*	health impact assessment	student	jobsite	law*
injur*	health surveys	vocational education		policy
hazard*	health status indicators	young adj2 adult*		polic*
accident*	standards [st.fs.]	teen		program*
exposure*		adolescent*		

Abbreviation: PICO, population, intervention, comparison, outcome.

occurred in agricultural, manufacturing or health care settings.

Twenty-one articles both described and assessed an intervention applicable to young workers. Of these, eleven studies (52%) assessed an educational intervention, presented in Table 2. Many of these used indirect impacts to measure effectiveness, such as changes to knowledge, perceived risk, intentions, behaviours or curriculum quality. These impacts are indirect because they do not necessarily lead to fewer or less severe injuries. Two studies directly measured injury reductions, one study measured cost reductions and one study measured reductions in hazardous exposures.^{14,16}

Five studies (24%) assessed the impact of an environmental intervention (Table 3). Three studies measured impacts to hazardous exposures.^{17,19} The remaining two studies assessed impact on behaviour, intentions and perceived effectiveness of the intervention.^{20,21}

Five studies (24%) assessed an intervention targeted to enforcing safety policies or procedures (Table 4). Two studies measured the impact of the interventions on injury reductions (including fatal injuries) and one study also described legislative changes that occurred because of the intervention.^{22,23} Two studies assessed the impact of safety inspections that were initiated as a result of the intervention and one study measured hazardous exposures.^{24,26}

Discussion

There is a vast body of research in the field of occupational safety for young workers, describing who is injured or

killed and under what circumstances. A substantial subset of this work describes injury risks, rates and severity. Surfacing in the field is work that attempts to explore ways of removing or reducing the risk of injury through interventions that target the worker at an individual or population level, or the workplace environment or culture. Many studies describe these interventions, but few assess them, especially in terms of their impact on reducing injuries.

Education

There appears to be an abundance of studies describing injury prevention initiatives that take an educational approach, since evaluating change in knowledge is a familiar task in Western society. Knowledge test scores are very easy to compare before and after an educational program, as well as being assessed periodically to track knowledge retention. In addition, educational interventions are popular because they can be very flexible in scope, application and cost, making them an attractive option for many employers. From a public health perspective, education is a practical approach since programs can be integrated into existing school curricula, thus efficiently targeting workers just as they are entering the workforce. The studies included in this review effectively demonstrated that many types of educational interventions are very good ways to produce the desired changes in knowledge.

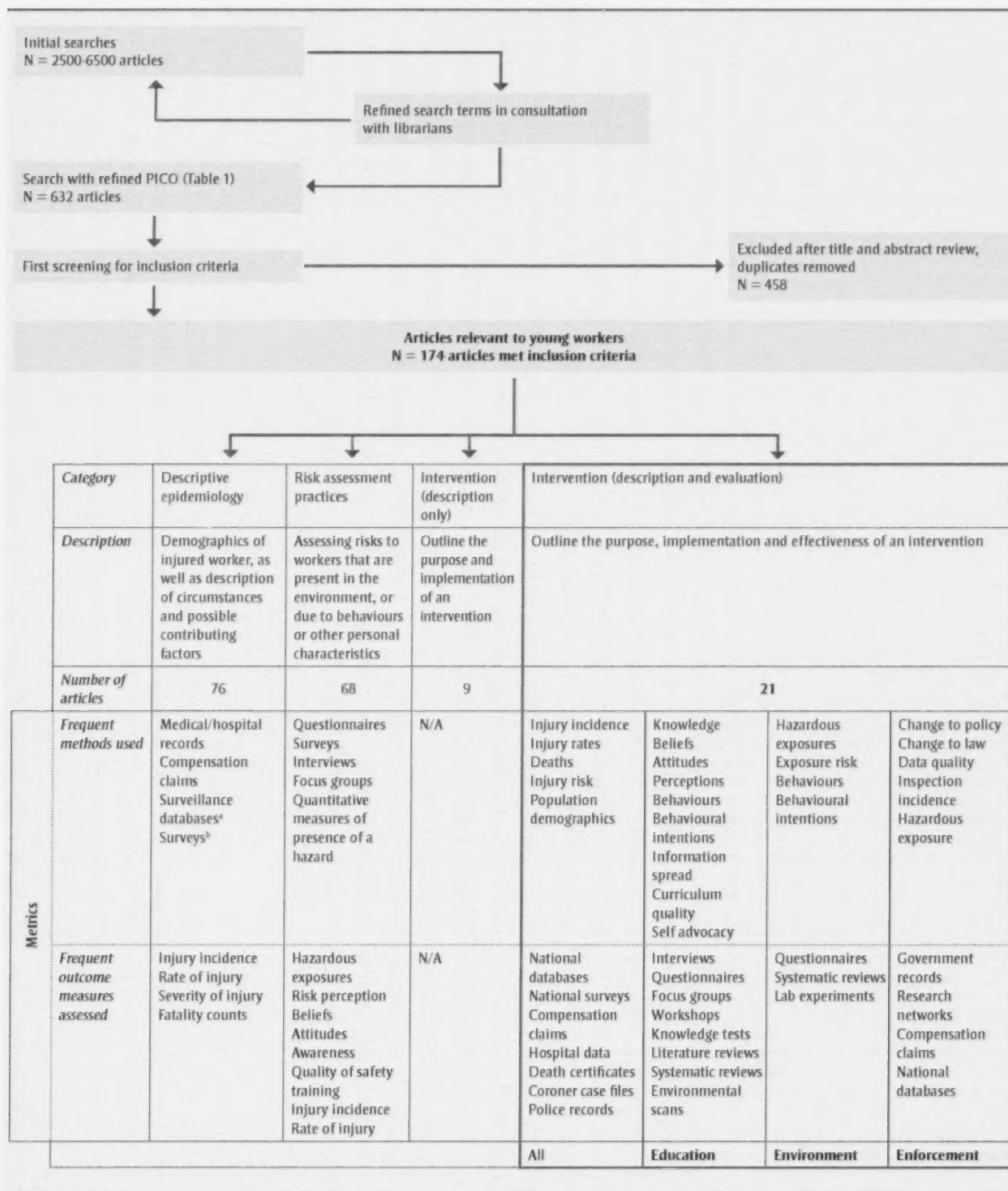
Less straightforward is the link between education programs, changes in knowledge and injury prevention. The goal of educating workers is ultimately to elicit specific safety behaviours at the necessary

times. Objectively measuring behaviour in a real-world setting is a very challenging and potentially expensive task, which may be why research evaluations often measure behavioural intentions, or self-reported safety behaviours. These measures provide valuable information about part of the impact of education, but still do not establish a direct link to achieving reduced injuries.

Burke and colleagues conducted a meta-analysis of quasi-experimental studies evaluating the relationship between learner engagement and injury reductions.¹⁴ They concluded that all levels of engagement in the safety classroom produced reductions, but that highly engaging curricula translated into the largest reductions.¹⁴ Another experimental study assessed the role of education in reducing cutting injuries when workers were supplied with an ergonomically superior cutting tool.¹⁵ Worker compensation claims were tracked for one year after the tool was introduced. Sites that received the tool plus education had a greater reduction in claims (-3.5 injuries per 100 000 man-hours) than the sites that received education alone (-1.5), or the control group (-1.6). The researchers concluded that education regarding correct use of the new tool was the determining factor in reducing injuries.¹⁵ These two studies demonstrated injury reductions because of education, but did not further explain how or why education impacted injuries.

Still, there is little doubt that some education or training is invariably better than none at all. Teaching young workers how to be safe on the job is, therefore, an essential component of any injury prevention program. Beyond increasing knowledge, the studies in this review suggest that there are additional metrics that could measure the quality and impact of education: 1) perceived control over a specified risk, 2) match between the program and the worker in terms of language, education, literacy level and developmental stage, and 3) degree to which the young worker feels engaged in the curriculum. The first was shown by Arcury and colleagues to drive workers' safety behaviour.²⁷ Workers who received the educational intervention developed an increased sense of control over their personal level of exposure to risk and this directly correlated to their motivation to change their behaviour.²⁷ The latter two metrics

FIGURE 1
Flowchart of article categorization and metric abstraction summary



Abbreviation: PICO, population, intervention, comparison, outcome.

^a Such as trauma registries or government records.

^b Such as the National Health Interview Survey.

TABLE 2
Studies evaluating an intervention within the education domain

Study	Intervention	Context	Main findings	Outcome measures	Method
Arcury et al. ²²	Safety education (PACE program)	Agriculture USA	- Receiving information about pesticide safety decreased perceived risk and increased perceived control - Perceived risk was not related to safety behaviour	Impact on knowledge, perceived risk and behaviour	Interview
Banco et al. ¹⁵	Safety education and improved cutting tool	Retail USA	- The new case cutting tool combined with safety education was most effective in reducing cutting injuries - Group that received education alone had similar injury rates to control group	Impact on knowledge, injury incidence, compensation claims and associated costs	Experiment
Burke et al. ¹⁴	Safety education (various)	General Multiple countries	- As requirements for learner participation increased (engagement), knowledge acquisition increased and injuries/illnesses decreased - All levels of engagement produced meaningful behavioural performance improvements	Impact on knowledge, behaviour and injury incidence	Systematic review
Chin et al. ³²	Safety education (various) and information dissemination	General Canada	- Young worker injury prevention programs at the Federal and Provincial/Territorial levels do little to support self-advocacy - Programs are informational, rather than instructional	Impact on support for self-advocacy within 4 broad categories: 1. knowledge of self 2. knowledge of rights 3. communication 4. leadership	Literature review
Ehlers and Graydon ²³	Safety education and information dissemination	Agriculture USA	Partnerships with key industry organizations allow for wide dissemination of educational materials	Impact on community engagement	Workshop
Kahan et al. ²⁸	Safety education (company training program)	Manufacturing Israel	- WRTK legislation did not ensure that workers were aware of rights and job hazards - Training materials did not match workers' language, literacy or educational levels	Impact on knowledge	Interview and questionnaire
Linker et al. ²⁴	Safety education (high school curriculum)	General USA	Student knowledge increased after receiving the educational intervention	Impact on knowledge as well as teacher ratings of ease of implementation	Questionnaire and pre-test/post-test evaluations
Schulte et al. ²⁵	Safety education (workforce preparation programs)	General USA	Inclusion of OHS info is not consistent across a very broad range of workforce preparation programs	Inclusion/exclusion of OHS information in training program	Environmental scan
Teran et al. ²⁶	Safety education (ESL curriculum)	Agriculture USA	- School based ESL curriculum is an effective way to reach teen farmworkers - Nearly half of intervention group reported implementing behaviours and 73% reported sharing their new knowledge with others - Parent involvement with community workshops was received with enthusiasm but demonstrated no impact on student outcomes	Impact on knowledge, attitudes and behaviour	Interview, focus groups and pre-test/post-test evaluations
Lepping et al. ¹⁶	Aggression management training	Hospital United Kingdom	No correlation between aggression management training (formal de-escalation training or violence management training) and lower frequency of violence exposures	Impact on frequency of exposure to hazard (violence and aggression)	Validated questionnaire (Survey of Violence Experienced by Staff)
Tucker and Turner ²⁷	Safety education (various) and social marketing campaigns (various)	General Canada	Young workers are reluctant to speak out against unsafe work because of beliefs about the perils of doing so persist, despite prevalence of social marketing campaigns and targeted high school curricula	Impact on safety voice intentions (reporting an injury or safety concern)	Focus groups

TABLE 3
Studies evaluating an intervention within the environment domain

Study	Intervention	Context	Main findings	Outcome measures	Method
Adams et al. ²⁰	Warning signs	Heavy Industry Australia	- Third person effect: workers rate their own risk lower relative to other employees - Signs are rated equally effective even if one "essential" component is missing	Impact on behavioural intentions, as well as perceived effectiveness	Questionnaire
McDowell et al. ¹⁷	PPE	Beach cleaning USA	Anti-vibration gloves are not effective at attenuating the vibration frequencies and may even increase transmitted vibration and arm/hand fatigue	Exposure to hazard (transmitted vibration) and severity of hazard (vibration frequency)	Specialized apparatus
Salvatore et al. ²¹	Hand-washing stations, PPE and weekly educational sessions	Agriculture USA	Use of PPE and hand-washing behaviour improved during work hours, but end of day/after work behaviours did not	Impact on behaviour	Questionnaire
Ulrey and Fathallah ¹⁸	Weight transfer device (BNDR)	Heavy Industry USA	The device reduced low back strain during tasks performed with a stooped posture	Impact on muscle activity and body positioning	Specialized apparatus (electromyography)
Verbeek et al. ¹⁹	PPE and engineered noise controls	Multiple workplaces Multiple countries	- Legislation limiting noise exposure was effective in reducing hazardous exposure in one study - Effectiveness of wearing ear plugs depends on training and their correct use	Impact on injury rate, exposure to hazard (noise) and injury incidence	Systematic review (Cochrane)

Abbreviations: BNDR, bending non-demand return; PPE, personal protective equipment.

TABLE 4
Studies evaluating an intervention within the enforcement domain

Study	Intervention	Context	Main findings	Outcome measures	Method
Haviland et al. ²³	OSHA inspections	Manufacturing USA	- Inspections with penalties affected injury types related and unrelated to standards - Citations for violations of PPE requirements had the largest impact on preventing injuries - Inspections may spur managers to undertake safety measures that go beyond standard compliance	Impact on injury rate	OSHA inspection records, State Department of Labor and Industry records, UI records, compensation claims
Higgins et al. ²²	Improved surveillance through site inspections using FACE model	Multiple workplaces USA	Investigations of sites of fatal occupational injuries using the FACE model have contributed to greater information dissemination, change in state laws and reductions in fatal occupational injuries	Impact on data quality, reducing deaths and new legislation	Surveillance data (Fatality Assessment and Control Evaluation)
Rowlinson and Jia ²⁶	A protocol to manage heat stress at both the worker and management levels	Construction China	A new protocol for developing heat stress management systems for managers deciding on work-rest regimens and workers' self-regulation is more efficient than current guidelines	Impact on heat strain and workflow	Specific apparatus (Wet Bulb Globe Temperature monitor)
Kica and Rosenman ²⁵	Improved surveillance to trigger site inspections by MIOSHA	Multiple workplaces USA	- The new surveillance system identified a significantly higher number of injury cases that prompted site inspections - These inspections would not have otherwise occurred	Impact on site inspections initiated	Comparison of cases identified by Bureau of Labor Statistics and new surveillance (includes hospital records and compensation claims)
Largo and Rosenman ²⁴	Improved surveillance to trigger site inspections by MIOSHA	Multiple workplaces USA	- The new surveillance system identified a significantly higher number of injury cases that prompted site inspections - These inspections would not have otherwise occurred	Impact on site inspections initiated	Comparison of cases identified by Bureau of Labor Statistics and new surveillance (includes hospital records and compensation claims)

Abbreviations: FACE, Fatality Assessment and Control Evaluation; MIOSHA, Michigan Occupational Safety and Health Administration; OSHA, Occupational Safety and Health Administration; PPE, personal protective equipment; UI, unemployment insurance.

were associated with increased knowledge acquisition.^{14,28} Although no studies assessed long-term knowledge retention, the studies in this review suggest that the immediate value of an educational program will be enhanced if appropriate metrics can be identified and applied.

Environment

Few studies evaluating environmental interventions were identified. Making changes to the working environment or providing personal protective equipment (PPE) both require substantial investment. In addition, two studies were conducted in a laboratory setting using sophisticated apparatus for taking precise measurements. The costs associated with generating data in this way could be a significant barrier for researchers, which may help explain the low number of studies in this domain.

However, two studies suggest that perceptions of safety may interact with the environment to increase young worker vulnerability. Burt and colleagues found new, young recruits often had inflated safety expectations that did not align with the reality of the workplace safety climate they were about to enter, which in turn increased injury risk.²⁹ Adams and colleagues also demonstrated a mismatch between safety perceptions and the reality of hazards in the workplace.³⁰ The researchers found that hazard warning signs did affect behavioural intentions, but were also subject to the "third-person effect", which means that workers who saw the sign tended to think that others were more vulnerable than themselves.³⁰ These studies suggest that metrics measuring risk perception and safety culture could be important to include when assessing the physical environment of young workers.

More studies are needed to address the specific impact of environmental interventions on injury risk, severity and rates among young workers. Studies that look at factors beyond the use of personal protective equipment to assess the design of the physical working environment are needed. These additional ways to mitigate risks and protect workers were not explored in-depth by the studies revealed by this review.

Enforcement

Enforcement has very broad implications for workers and employers. Safety policy affects all aspects of a workplace. Thus, decision-makers can be in the position of needing to balance productivity or efficiency with safety requirements, particularly when one places direct limits on the other. Developing, implementing, communicating and enforcing a policy change is time- and labour-intensive. Reversing the change if it proves ineffective has enormous negative consequences for everyone involved. Aside from the expenses incurred by the intervention, too many changes can cause confusion at all levels of an organization, as well as undermine worker trust in management, potentially affecting future compliance with safety regulations. Thus, changes to safety policy (and on a larger scale, legislation) occur slowly because they require extensive consultation, stakeholder input, and investment to ensure that the desired outcome results from the change.

In light of these considerations, very few studies were found which assess enforcement. In addition, the studies in this group were mostly qualitative, containing very detailed process descriptions of how meaningful changes to policy or legislation were achieved, as well as direct impacts on injury rates and occupational fatalities. It is worth highlighting that two of the five studies explored the role that quality surveillance plays in injury reduction.²⁴⁻²⁵ The researchers demonstrated that quality surveillance should not only obtain data from multiple sources, but must also connect to a network to leverage the data in a timely manner. Safety inspections were initiated more quickly, and in more cases, because the surveillance network included contacts within the Occupational Safety and Health Administration (OSHA). Clearly, collaboration is necessary within an enforcement framework to ensure that useful data is first generated and then effectively leveraged. Researchers also demonstrated that changes to laws can be achieved with solid empirical evidence to justify the change, especially when combined with sufficient civic pressure.²² Although this group of studies used metrics that could be applied to workers of any age, the findings serve as a reminder that "top down" interventions—such as safety audits—can be a powerful way of protecting young workers.

The way forward: developing appropriate metrics to assess young worker injury prevention programs

One additional study did not fit with our review framework, but is nonetheless relevant and important to discuss. Wurzelbacher and Jin developed and tested a tool for predicting future worker compensation outcomes.³⁰ They defined groups of metrics that could be used to assess interventions addressing injury or illness events directly (termed "primary prevention"), as well as interventions to detect injury or illness early before it progresses in severity ("secondary prevention") and interventions that reduce the duration of time-off work following an injury or illness ("tertiary prevention"). They grouped their metrics according to predictive ability: "leading metrics" that indicate risk or potential causes of injury and are, thus, useful for predicting future injuries, or "trailing metrics" that describe what happened previously, but are not necessarily reliable for projecting into the future. Their tool was developed through a preliminary literature review to define key injury prevention program elements. Then, detailed questionnaires were administered to participating companies. The questionnaires were developed from the OSHA Voluntary Protection Program and the NIOSH ergonomic programs to capture both pre- and post-injury elements. Self-rated measures of each company's prevention efforts were combined with measures of past losses, such as injury incidence and compensation claims. By combining leading metrics with trailing metrics in their analyses, the researchers successfully demonstrated the application of the tool, predicting worker compensation cases based on metrics applied to the occupational health and safety programs of participating companies.³⁰ Although the metrics developed by Wurzelbacher and Jin addressed manufacturing, with some emphasis on musculoskeletal disorders, we believe their study is an appropriate model for future work in developing valid leading metrics specific to young workers in other common occupational settings, together with the application of these metrics to injury prevention programs for youth.

Limitations

This review was subject to several limitations. First, articles in English only were included, which may have resulted in

excluding relevant studies. Secondly, the search was limited by time and budgetary constraints so manual search strategies were not included in the methodology. While the search included articles published in early 2015, time limitations did not permit the search to be updated after the refined PICO (population, intervention, comparison, outcome) search was performed. To minimize the chances of missing a useful article, the search criteria were kept deliberately broad to acquire as many articles as possible. Considering the very few articles found assessing young worker injury prevention programs specific to federally regulated workplaces, this strategy provided broader discussion by highlighting a very important gap that needs to be addressed by future research work.

Finally, the main objective of this review was to reveal the scope of commonly-used metrics for assessing young worker injury prevention programs. As such, quality assessment of each study included in the review was not part of the review methodology, so thematic findings should be interpreted with caution.³¹ These findings are meant to highlight seeming gaps or shortfalls in the discussion of youth occupational injuries, to help experts focus their critical eye on the components of any evaluation methodology applied to workplace injury prevention programs. This study was intended to be a first step towards refining priorities for emerging research in assessing young worker injury prevention.

Conclusion

The literature describing metrics for the assessment of young worker injury prevention efforts is still in its infancy. The few studies selected in this review provided some information on how to determine the quality of an intervention, but very few demonstrated effectiveness in terms of the ultimate goal of such efforts: reducing injuries. More studies are needed to identify robust metrics that establish links between injury prevention programs and concrete reductions in injury rates. The framework developed by Wurzelbacher and Jin may be a useful tool to be incorporated in future program assessments, as a model process to develop valid, leading metrics to predict the change in injury rates. In addition, future work is needed to explore the reasons why safety interventions work or do not work. Current

literature suggests that injury prevention for young workers should span the educational, environmental and enforcement domains. The next step is to develop youth-specific metrics that predict occupational injury rates. Researchers, safety consultants, policymakers and program planners will then be positioned to systematically assess existing programs, as well as design new programs that are grounded in the best evidence available. Until quality, youth-specific metrics are rigorously developed, the evidence found by this review suggests that a gap remains between research and evidence-based programming to prevent injury among young workers.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

All authors read and gave final approval of this version to be published. IP and AM designed the study and developed the data collection and analysis protocols. BPP completed the data acquisition. JS and BPP analysed the data. JS drafted the paper. IP and AM critically reviewed and revised the paper.

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Quantile regression analysis of language and interpregnancy interval in Quebec, Canada

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Abstract

Introduction: Short and long interpregnancy intervals are associated with adverse perinatal outcomes such as miscarriage and preterm delivery, but cultural differences in interpregnancy intervals are understudied. Identifying cultural inequality in interpregnancy intervals is necessary to improve maternal-child outcomes. We assessed interpregnancy intervals for Anglophones and Francophones in Quebec.

Methods: We obtained birth records for all infants born in Quebec, 1989–2011. We identified 571 461 women with at least two births, and determined the interpregnancy interval. We defined short interpregnancy intervals (< 18 months) as the 20th percentile of the distribution, and long intervals (≥ 60 months) as the 80th percentile. Using quantile regression, we evaluated the association of language with short and long intervals, adjusted for maternal characteristics. We assessed differences over time and by maternal age for disadvantaged groups defined as no high school diploma, rural residence, and material deprivation.

Results: In adjusted regression models, Anglophones who had no high school diploma had intervals that were 1.0 month (95% CI: -1.5 to -0.4) shorter than Francophones at the 20th percentile of the distribution, and 1.9 months (-0.5 to 4.3) longer at the 80th percentile. Results were similar for Anglophones in rural and materially deprived areas. The trends persisted over time, but were stronger for women < 30 years. There were no differences between advantaged Anglophones and Francophones.

Conclusion: Disadvantaged Anglophones are more likely to have short and long interpregnancy intervals relative to Francophones in Quebec. Public health interventions to improve perinatal health should target suboptimal intervals among disadvantaged Anglophones.

Keywords: birth intervals, cultural deprivation, language, socioeconomic factors

Introduction

A growing number of studies report ethnocultural differences in maternal-child health indicators, including preterm birth, delayed fetal growth and stillbirth.^{1–3} However, ethnic or cultural differences in interpregnancy intervals are rarely studied. In the United States, ethnic minorities have interpregnancy intervals that are disproportionately more extreme on both ends of the distribution. Black women

have a higher risk of short (< 18 months) and long (≥ 60 months) interpregnancy intervals compared with majority White women, and Hispanic women tend to have longer intervals.^{4–7} Short and long interpregnancy intervals are associated with miscarriage, premature rupture of membranes, preeclampsia, maternal cardiovascular disease and mortality.^{8–11} Suboptimal intervals increase the risk of preterm delivery, small-for-gestational-age birth, congenital anomalies, autism disorder,

Highlights

- We investigated differences in interpregnancy intervals between the Anglophone minority and Francophone majority in Quebec, Canada.
- Disadvantaged Anglophones had more suboptimal intervals than Francophones.
- Very short and long interpregnancy intervals were both more common in disadvantaged Anglophones.
- The trends persisted over time, and were stronger for young women.
- There were no differences between advantaged Anglophones and Francophones.

and fetal and infant mortality.^{9,12,13} It is thought that short interpregnancy intervals do not give women sufficient time to recover from the physical stress of the previous pregnancy, including nutritional depletion.^{8,10,14} By contrast, long interpregnancy intervals do not benefit from adaptations in the genital and cardiovascular systems that recede naturally with time. It is thought that the physiological capacities of women become comparable to those of the first pregnancy, where the risk of diverse maternal-child outcomes is higher.¹⁴ These effects are believed to be independent of maternal age.^{8,10,14} Better documentation of ethnocultural differences in interpregnancy intervals is needed, since attempts to optimize interpregnancy intervals may improve maternal and perinatal outcomes.

Our objective was to determine if differences in interpregnancy intervals were present between Anglophones and Francophones

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in the province of Quebec, Canada. French is the official language in Quebec, where most of the population is Francophone (79.1% in 2016) and the minority is Anglophone (9.7%).¹⁵ In Quebec, language is associated with cultural norms and access to health care, and is frequently used to measure health differences.¹⁶ In recent decades, Anglophone socioeconomic status has decreased due to higher unemployment rates and larger proportions living below the low income cut-off compared with Francophones.¹⁷ Several studies indicate that Anglophones, particularly socioeconomically disadvantaged Anglophones, have increasing rates of stillbirth, preterm birth and small-for-gestational-age birth.^{18,19} We investigated the possibility that lingo-cultural differences in interpregnancy intervals were present in Quebec, and assessed trends over time and socioeconomic status. Our hypothesis was that socioeconomically disadvantaged Anglophones are presently at greater risk of suboptimal interpregnancy intervals compared with Francophones.

Methods

Data

We obtained live birth and stillbirth files from the Ministry of Health and Social Services for all infants to women who gave birth in Quebec, Canada, 1989–2011.²⁰ The data covered the entire province, and contained maternal characteristics such as language and parity as well as information on the prior delivery. We selected women who had at least two births and focussed the analysis on the interpregnancy interval between the first and second child, as women in Quebec rarely have a third child. We excluded multiple births to rule out the contribution of pregnancy-specific disorders not found in singleton births. There were in total 622 812 women who delivered at least two times and had information on language and the timing of the first and second birth.

Language

To determine the maternal language, we used the language spoken at home which was self-reported on birth certificates and reflects the language used by both parents in the home setting. We considered mothers who reported English with or without another non-French language as Anglophone, following previous research.^{17,19,21} We considered mothers who reported

French with or without another non-English language as Francophone. Due to small numbers, we excluded 10 004 bilingual French-English women, as these were too few to analyze. Similarly, we excluded 41 347 women with other languages, a heterogeneous group that comprised a wide range of languages which was difficult to interpret. The final sample comprised 571 461 Anglophone and Francophone women (Figure 1). For simplicity, we used the terms language and language spoken at home interchangeably hereafter to describe the results.

Interpregnancy interval

The interpregnancy interval was defined as the time between the first delivery and conception of the second pregnancy.^{4,7,9,22,23} The World Health Organization encourages a minimum interval of 24 months between pregnancies,⁹ following evidence that intervals shorter than 18 months, or longer than 60 months, increase the risk of adverse maternal and perinatal outcomes.^{8–13} To calculate the interpregnancy interval, we subtracted the date of delivery of the first-born infant from the conception date of the second-born infant. We estimated the conception date by subtracting the gestational age from the delivery date, with a two-week correction for the average time of ovulation. We expressed the interpregnancy interval as a continuous variable in months, and for descriptive statistics categorized the interval

as short (less than 18 months), optimal (18 to 59 months), or long (60 months or more) following previous literature.^{4,5,7,9,22}

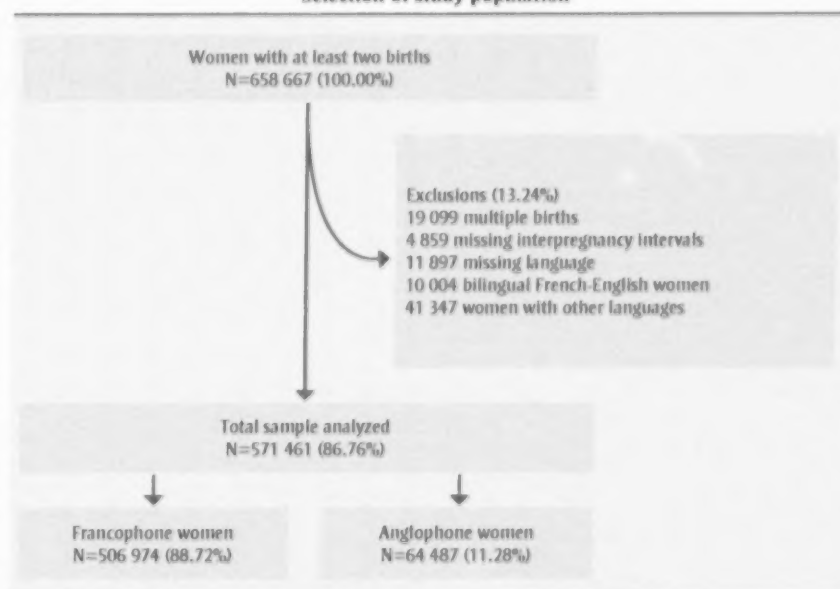
Socioeconomic status

We selected three markers of socioeconomic status, including education (no high school diploma, high school diploma/post-secondary training, university, unknown), place of residence (urban, rural, unknown), and material area deprivation quintile based on a composite score of census data on neighbourhood income, employment and education (low, low-middle, middle, middle-high, high deprivation, unknown).²⁴ Education and place of residence were measured at an individual-level, while material deprivation was measured at an area level based on the 1991, 1996, 2001 and 2006 Censuses. We selected these indicators based on current literature of socioeconomic status. Education is a well-established marker of socioeconomic status shown to be associated with interpregnancy intervals.^{4,7,22} Rurality is a marker of low socioeconomic status also associated with reproductive health, including short interpregnancy intervals.^{23,25} Material deprivation is an indicator of area socioeconomic status frequently used to investigate perinatal health differences.^{26,24}

Covariates

We accounted for additional covariates possibly related to the interpregnancy

FIGURE 1
Selection of study population



interval, including maternal immigrant status (Canadian-born, foreign-born, unknown) and time period at second delivery (1989–1999, 2000–2011). Several studies report an association between foreign place of birth and interpregnancy intervals.^{6,7,22} We included periods to evaluate trends over time, and limited the analysis to two time periods to make sure there were enough women in each period to enable comparisons. We did not adjust for maternal age in the primary analysis, as women who are older at their first pregnancy cannot have long interpregnancy intervals for physiological reasons. Adjustment for maternal age may cause over-adjustment bias in regression models because there are no older women with long interpregnancy intervals.²⁶

Data analysis

We computed the proportion of Anglophone and Francophone women with short (less than 18 months), optimal (18 to 59 months), and long (60 months or more) interpregnancy intervals, and plotted the distribution for each language group according to socioeconomic characteristics. In regression models, we analyzed the interpregnancy interval as a continuous variable. Linear regression is the traditional method used for continuous outcomes. Linear regression estimates the mean difference in interpregnancy intervals between Anglophones and Francophones, but provides no estimate of the difference at the tails of the distribution,²⁷ which is a disadvantage since very low and very high intervals are problematic for maternal-infant health, not mean intervals.

We instead used quantile regression, a method that overcomes the limitations of linear regression by analyzing the entire distribution of the interpregnancy interval. Quantile regression divides the distribution of the interpregnancy interval in quantiles of equal proportion.²⁸ The relationship with language is modelled at each quantile of the interpregnancy interval.²⁷ Thus, quantile regression can assess the association of language with short interpregnancy intervals, as well as with long interpregnancy intervals.

We used quantile regression models with the interpregnancy interval divided in 20 equal quantiles. We considered intervals at the 20th percentile of the distribution as short, and intervals at the 80th

percentile as long, because these cut-off points approached the < 18 months and ≥ 60 months used in traditional analyses.^{4,5,7,9,22} For both short and long intervals, we obtained the absolute difference in the interpregnancy interval between Anglophones and Francophones in months. We computed 95% CIs for all estimates, and adjusted for maternal education, rural residence, material deprivation, immigrant status, and time period at second delivery. We tested the interaction of language with socioeconomic characteristics, including maternal education, rural residence, and material deprivation. We assessed trends over time by comparing the association between language and interpregnancy intervals in 1989–1999 with the association in 2000–2011. Because maternal age may modify the associations, we ran regression models with the data stratified by age at first birth (< 30 vs. ≥ 30 years).

Sensitivity analysis

We performed a range of sensitivity analyses. We estimated the association of language with interpregnancy intervals between the second and third birth for 210 631 women, and between the third and fourth birth for 60 972 women, to determine if linguistic differences persisted over the reproductive course of women. We examined models for Canadian-born and foreign-born mothers separately, to make sure that linguistic differences were not due to immigration. We examined the impact of excluding women who had stillbirth at first pregnancy, using the mother tongue of each parent instead of language spoken at home, and adjusting for maternal age. Finally, we assessed associations after excluding women from Aboriginal areas, since fertility is higher in these regions.

We performed the analysis in SAS version 9.3 (SAS Institute Inc., Cary, NC, USA). We obtained an ethics waiver from the institutional review board of the University of Montréal Hospital Centre, as the study abided by ethical requirements for research on people in Canada.

Results

In this study, there were 506 974 Francophone and 64 487 Anglophone women (Table 1). 11.3% (95% CI: 11.2–11.4) of women were Anglophone. This proportion was slightly lower in women with

interpregnancy intervals shorter than 18 months (10.6%; 95% CI: 10.5–10.8) and higher in women with intervals of 60 months or more (12.4%; 95% CI: 12.2–12.7). Interpregnancy intervals were generally longer for Anglophones than Francophones. Anglophones had a lower proportion of interpregnancy intervals shorter than 18 months (31.15% (20 089/64 487) vs. 33.35% (169 068/506 974) for Francophones, $p < .001$), and a greater proportion of intervals longer than 60 months or more (14.67% (9 458/64 487) vs. 13.14% (66 599/506 974) for Francophones, $p < .001$). Anglophones who had no high school diploma, lived in rural areas, or were materially deprived had a higher proportion of very short and long interpregnancy intervals than Francophones (Figure 2). The distribution of interpregnancy intervals was similar for Francophones and Anglophones who had university diplomas, lived in urban areas, or had low material deprivation.

Quantile regression models adjusted for socioeconomic characteristics suggested that there was a linguistic difference in long (80th percentile) but not short (20th percentile) interpregnancy intervals (Figure 3). At the 80th percentile, Anglophones had intervals that were 0.8 months longer than Francophones (95% CI: 0.4–1.3). Interaction terms suggested that differences at the 80th percentile were greater for Anglophones who lived in rural areas ($p < .001$), or were materially deprived ($p < .001$). Although there was no difference at the 20th percentile between Anglophones and Francophones overall, interaction terms with socioeconomic characteristics suggested that intervals were shorter for Anglophones who had no high school diploma ($p < .001$), lived in rural areas ($p < .001$), or were materially deprived ($p = .04$).

Short interpregnancy intervals

When we examined each socioeconomic group separately, results confirmed that disadvantaged Anglophones had shorter interpregnancy intervals than Francophones at the 20th percentile of the distribution (Figure 4). Anglophones with no high school diploma had intervals that were 1.0 months shorter than Francophones (95% CI: –1.5 to –0.4), and Anglophones in rural areas had intervals that were 0.7 months shorter (–1.0 to –0.3). However, intervals of materially deprived Anglophones were not statistically different

TABLE 1
Distribution of interpregnancy intervals for Francophones and Anglophones according to maternal characteristics, 1989–2011, Quebec^a

	Total no. Francophone births	Francophone interpregnancy interval			Total no. Anglophone births	Anglophone interpregnancy interval		
		< 18 months N (%)	18-59 months N (%)	≥ 60 months N (%)		< 18 months N (%)	18-59 months N (%)	≥ 60 months N (%)
Education								
No high school diploma	50 219	15 777 (31.4)	24 635 (49.1)	9 807 (19.5)	4 673	1 521 (32.5)	2 166 (46.4)	986 (21.1)
High school diploma	294 582	94 821 (32.2)	157 661 (53.5)	42 100 (14.3)	34 183	10 143 (29.7)	18 276 (53.5)	5 764 (16.9)
University	141 913	52 095 (36.7)	78 124 (55.1)	11 694 (8.2)	21 651	7 250 (33.5)	12 427 (57.4)	1 974 (9.1)
Residence								
Urban	386 250	126 916 (32.9)	207 695 (53.8)	51 639 (13.4)	58 875	18 145 (30.8)	32 169 (54.6)	8 561 (14.5)
Rural	116 957	40 758 (34.8)	61 671 (52.7)	14 528 (12.4)	5 243	1 822 (34.8)	2 575 (49.1)	846 (16.1)
Material area deprivation								
Low	89 948	30 738 (34.2)	49 539 (55.1)	9 671 (10.8)	20 086	6 575 (32.7)	11 335 (56.4)	2 176 (10.8)
Low-middle	104 191	34 437 (33.1)	56 859 (54.6)	12 895 (12.4)	12 385	3 748 (30.3)	6 897 (55.7)	1 740 (14.0)
Middle	103 812	34 480 (33.2)	55 638 (53.6)	13 694 (13.2)	9 604	2 888 (30.1)	5 156 (53.7)	1 560 (16.2)
Middle-high	100 086	33 508 (33.5)	52 592 (52.5)	13 986 (14.0)	9 390	2 886 (30.7)	4 914 (52.3)	1 590 (16.9)
High	93 042	30 474 (32.8)	48 356 (52.0)	14 212 (15.3)	10 695	3 269 (30.6)	5 420 (50.7)	2 006 (18.8)
Immigrant status								
Canadian-born	465 011	157 116 (33.8)	249 058 (53.6)	58 837 (12.7)	43 028	13 819 (32.1)	23 941 (55.6)	5 268 (12.2)
Foreign-born	37 448	10 515 (28.1)	19 860 (53.0)	7 073 (18.9)	19 567	5 683 (29.0)	10 030 (51.3)	3 854 (19.7)
Time period at second delivery								
1989-1999	255 492	85 854 (33.6)	136 808 (53.5)	32 830 (12.8)	30 604	9 783 (32.0)	16 624 (54.3)	4 197 (13.7)
2000-2011	251 482	83 214 (33.1)	134 499 (53.5)	33 769 (13.4)	33 883	10 306 (30.4)	18 316 (54.1)	5 261 (15.5)
Total	506 974	169 068 (33.3)	271 307 (53.5)	66 599 (13.1)	64 487	20 089 (31.2)	34 940 (54.2)	9 458 (14.7)

^a Percentages are for row totals (not column totals) for Francophones and Anglophones separately.

relative to Francophones (0.2 months shorter; 95% CI: -0.6 to 0.1). Anglophones who had university diplomas, lived in urban areas, or had low material deprivation had interpregnancy intervals that were similar to Francophones.

Long interpregnancy intervals

In contrast, disadvantaged Anglophones had longer interpregnancy intervals at the 80th percentile of the distribution compared with Francophones (Figure 4). Anglophones in rural areas had intervals that were 5.0 months longer than Francophones (95% CI: 3.5 to 6.5), and materially deprived Anglophones had intervals that were 2.7 months longer (1.4 to 4.0). Anglophones with no high school diploma had intervals that were 1.9 months longer than Francophones, although the difference was not statistically significant (95% CI: -0.5 to 4.3). In contrast, Anglophones who had university diplomas or who lived in urban areas had interpregnancy intervals that were similar to Francophones, and

Anglophones with low material deprivation had intervals that were 1.4 months shorter (95% CI: -2.1 to -0.7).

When we examined temporal trends over time, the difference between socioeconomically disadvantaged Anglophones and Francophones did not change over time. Differences between socioeconomically disadvantaged Anglophones and Francophones were, however, more prominent for women < 30 years compared with women ≥ 30 years (Figure 5). At the 20th percentile, Anglophones < 30 years with no high school diploma had intervals that were 0.9 months shorter than Francophones (95% CI: -1.5 to -0.3), and those in rural areas had intervals that were 0.7 months shorter (-1.1 to -0.3). At the 80th percentile, Anglophones < 30 years with no high school diploma had intervals that were 2.8 months longer than Francophones (95% CI: 0.2 to 5.3), those in rural areas had intervals that were 6.4 months longer (4.7 to 8.1), and those in materially deprived areas had intervals

that were 3.3 months longer (1.8 to 4.7). In contrast, disadvantaged Anglophones ≥ 30 years had interpregnancy intervals that were similar to Francophones.

In sensitivity analyses, linguistic differences in intervals between the second and third birth were similar to those between the first and second birth, however there was no difference in intervals between the third and fourth birth. Results were similar when data were stratified by maternal immigrant status, after excluding women with stillbirth at first pregnancy, and when we used the maternal or partner mother tongue as the exposure. Adjusting for maternal age had little impact on short intervals, and restricting to young women had no impact on long intervals. Excluding 2923 women from Aboriginal areas did not change the results.

Discussion

In this study, we found differences in short and long interpregnancy intervals

FIGURE 2
Distribution of interpregnancy intervals for Francophones and Anglophones, 1989–2011, Quebec

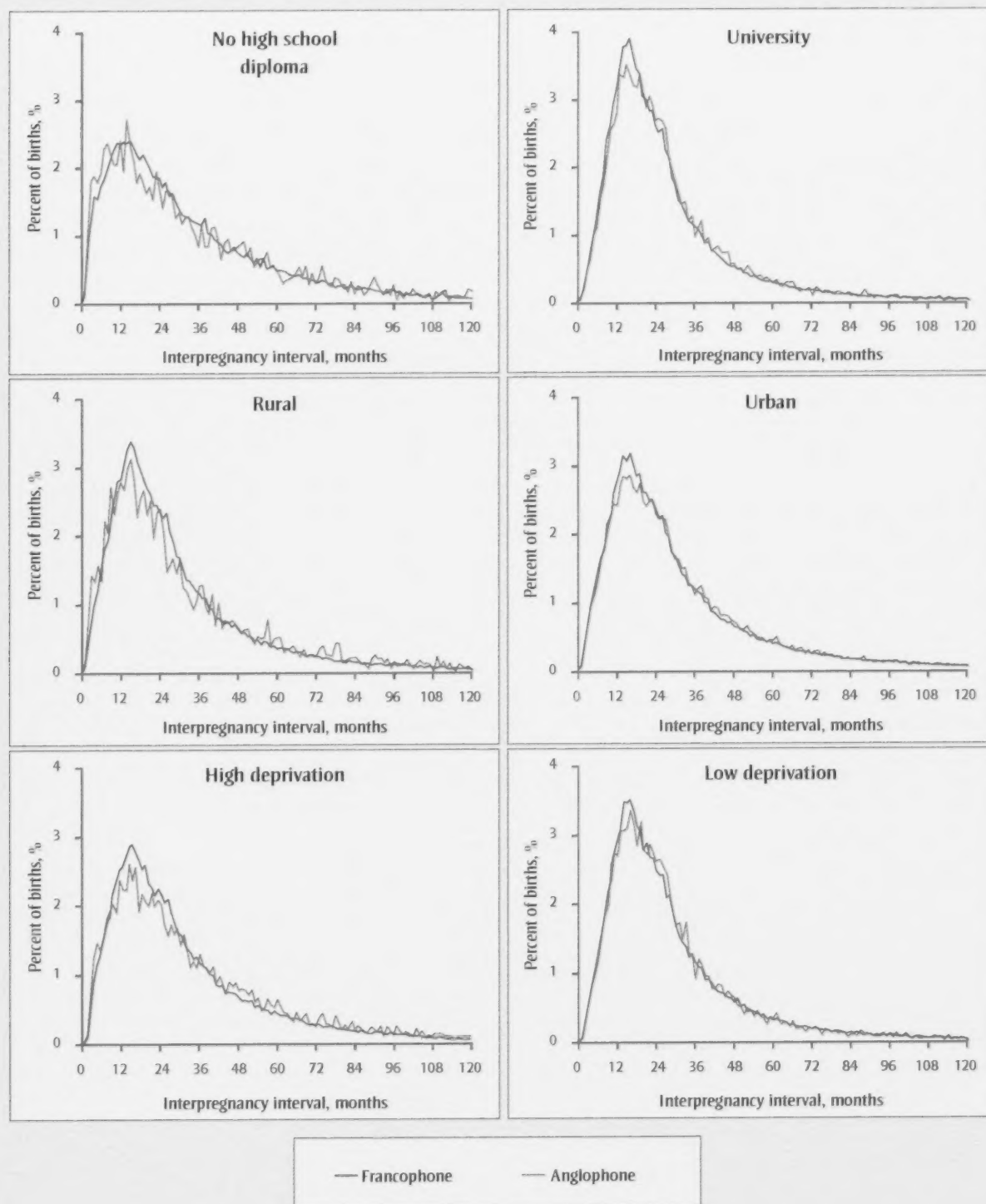
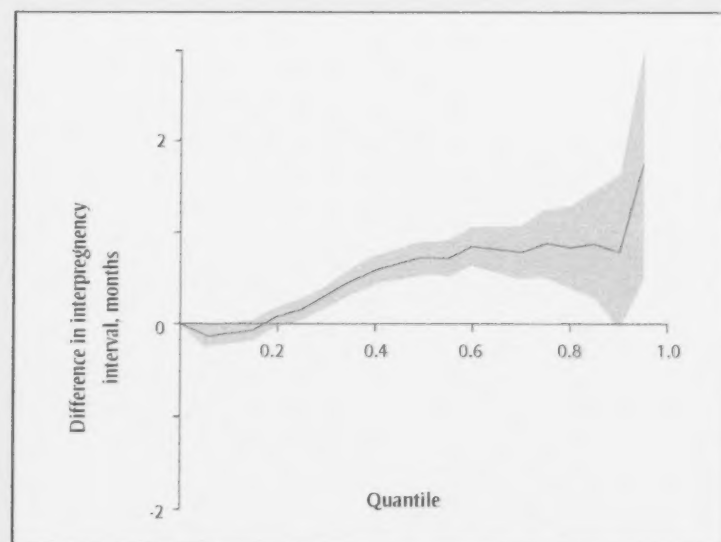


FIGURE 3
Difference in interpregnancy intervals between Anglophones and Francophones,
1989–2011, Quebec^a



	Quantile			
	0.2	0.4	0.6	0.8
Anglophone, interval in months	14.0	21.5	30.9	50.0
Francophone, interval in months	13.7	20.3	29.1	47.0

^aDifference in interpregnancy interval for Anglophones minus Francophones in months (bold line) and 95% CI (grey shade), adjusted for maternal education, rural residence, material area deprivation, immigrant status and period. The x-axis indicates the interpregnancy interval quantile, with 0.2 equivalent to short intervals and 0.8 long intervals. Positive values on the y-axis indicate that Anglophones have greater intervals than Francophones, and negative values that Francophones have greater intervals than Anglophones.

between Anglophones and Francophones of Quebec. Socioeconomically disadvantaged Anglophones had intervals that were less favourable than Francophones for both short and long intervals. At short intervals, Anglophones with no high school diploma, who lived in rural areas, or were materially deprived had interpregnancy intervals that were systematically shorter than Francophones. At long intervals, Anglophones with no high school diploma, who lived in rural areas, or were materially deprived had interpregnancy intervals that were systematically longer than Francophones. The differences persisted over time, and were stronger for younger women. In contrast there was no difference between socioeconomically advantaged Anglophones and Francophones. These findings add to the growing evidence that socioeconomically disadvantaged

Anglophones may be a vulnerable population in Quebec, and are concerning as Anglophones have higher fertility,²¹ and suboptimal interpregnancy intervals are associated with a wide range of adverse maternal and perinatal outcomes.

Few studies have attempted to measure cultural differences in interpregnancy intervals.^{4,7} These studies however do not investigate the entire distribution of interpregnancy intervals, and usually analyze the interval as a binary outcome. While the trends align with the results in our study, where minority Anglophones also had unfavourable interpregnancy intervals, it is difficult to know if the results are generalizable to minorities elsewhere.

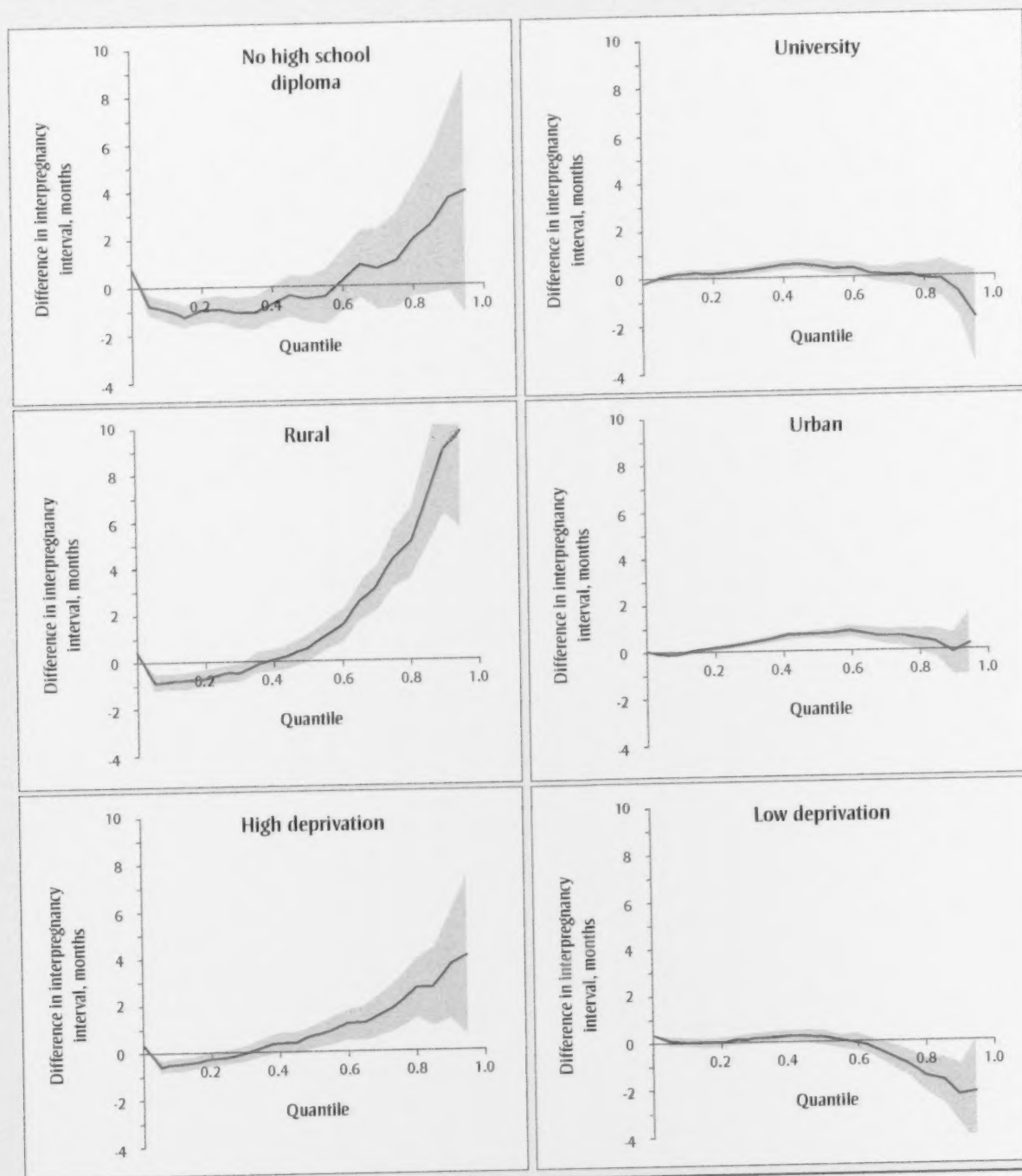
Moreover, there are limited data on how lingo-cultural differences in interpregnancy

intervals vary according to socioeconomic status. In some research, socioeconomically disadvantaged women have unfavourable interpregnancy intervals compared with advantaged women. Unemployment, low income, and rural residence are all associated with a higher risk of short interpregnancy intervals.^{6,23} Similarly, women with less education have a higher risk of long interpregnancy intervals compared with highly educated women.^{6,7} However, studies have not tested the possibility of interaction between ethnicity and socioeconomic status. Our results in fact suggest a strong interaction effect, as most of the difference between Anglophones and Francophones of Quebec was limited to disadvantaged women. There was no difference in interpregnancy intervals between advantaged Anglophones and Francophones. Breastfeeding may also affect interpregnancy intervals by delaying menstruation and the next pregnancy.⁹ Breastfeeding initiation and duration differs according to ethnicity, and high education tends to be associated with longer duration of breastfeeding.²⁹

Family planning may also differ between linguistic and cultural subgroups. Some women may time their second pregnancies based on culture, age, career, or future income. For example, employed women, or women who are in school may choose to delay pregnancy.⁴ However, researchers have shown that short interpregnancy intervals are frequently unplanned,⁵ particularly for disadvantaged women,²³ while long intervals can be markers of fertility problems or change of partner.³⁰ Indeed, we found that disadvantaged Anglophones who were young were more likely to have very short or long intervals compared with Francophones, suggesting that effects of language are more prominent in young mothers. Family planning may be influenced by health care services, and we cannot exclude the possibility of language barriers in access to information on reproductive health. Disadvantaged Anglophones may be more affected, and have fewer opportunities to receive appropriate advice on contraception and optimal timing of a second pregnancy. French is the official language in Quebec and it is generally easier to receive Francophone health services in many parts of the province, especially in rural areas.¹⁶

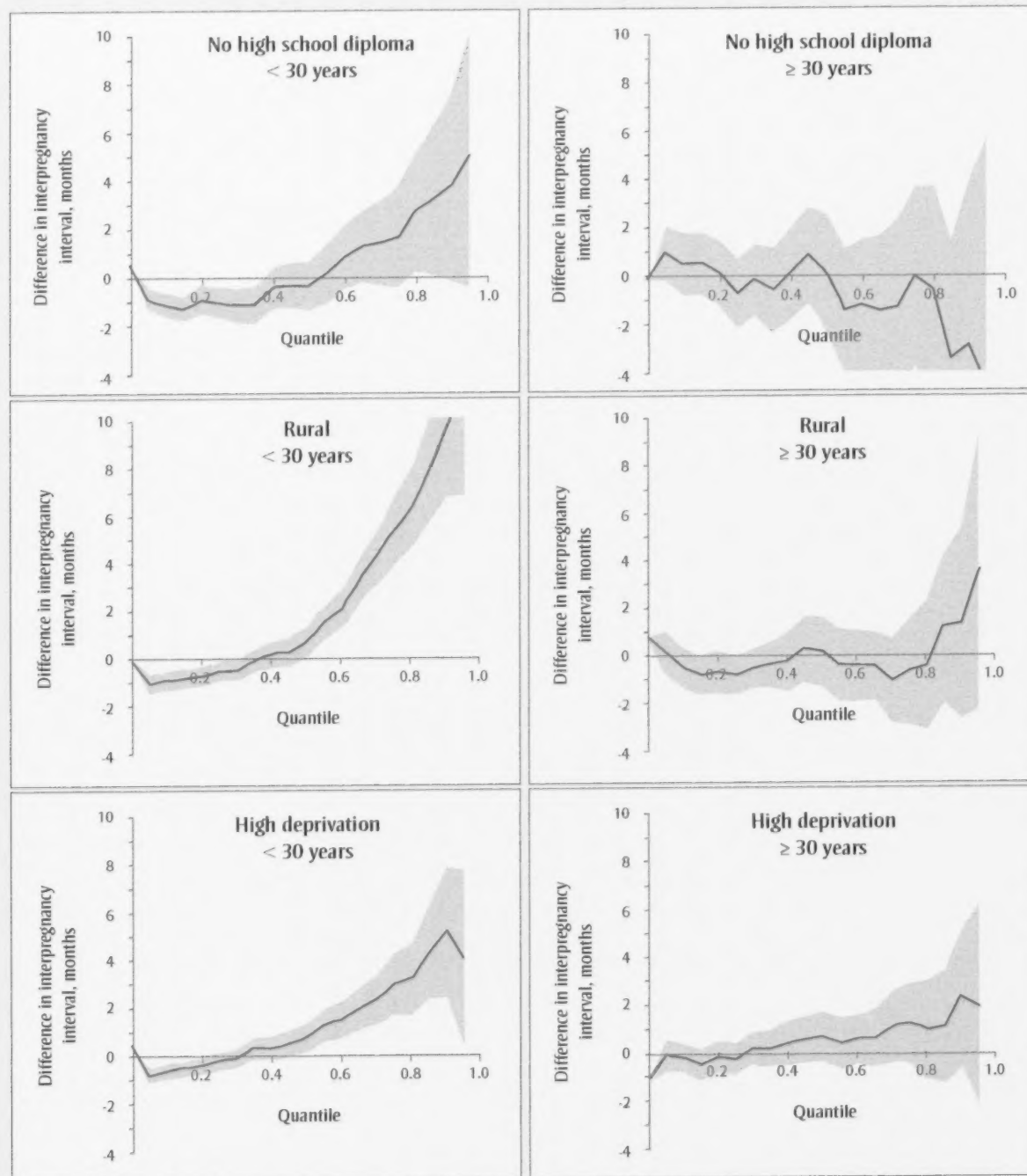
To our knowledge, temporal trends in interpregnancy intervals between ethnic,

FIGURE 4
Difference in interpregnancy interval between Anglophones and Francophones according to socioeconomic characteristics, 1989–2011, Quebec^a



^a Difference in interpregnancy interval for Anglophones minus Francophones in months (bold line) and 95% CI (grey shade), adjusted for maternal education, rural residence, material area deprivation, immigrant status and period. The x-axis indicates the interpregnancy interval quantile, with 0.2 equivalent to short intervals and 0.8 long intervals. Positive values on the y-axis indicate that Anglophones have greater intervals than Francophones, and negative values that Francophones have greater intervals than Anglophones.

FIGURE 5
Difference in interpregnancy interval between socioeconomically disadvantaged Anglophones and Francophones
by maternal age, 1989–2011, Quebec^a



^a Difference in interpregnancy interval for Anglophones minus Francophones in months (bold line) and 95% CI (grey shade), adjusted for maternal education, rural residence, material area deprivation and immigrant status. The x-axis indicates the interpregnancy interval quantile, with 0.2 equivalent to short intervals and 0.8 long intervals. Positive values on the y-axis indicate that Anglophones have greater intervals than Francophones, and negative values that Francophones have greater intervals than Anglophones. Results for women ≥ 30 years should be interpreted with caution as long interpregnancy intervals are rare in this group.

cultural or socioeconomic groups have not been studied in other countries. In Quebec, there is substantial evidence that disadvantaged Anglophones have increasing rates of stillbirth, preterm birth, and small-for-gestational-age birth.^{18,19} Anglophone fertility is also rising, particularly among materially deprived women.²¹ These trends coincide with rising unemployment and low income among Anglophones.¹⁶ The structure of language groups may also have changed over time due to disproportionate emigration of advantaged Anglophones to other Canadian provinces,³¹ and an increase and change in type of immigrants in Quebec. We found no evidence however that Anglophone-Francophone differences in interpregnancy intervals widened during the study.

Strengths and limitations

We had population-based data for more than 500 000 parous women in a large province of Canada, and used quantile regression, a method that estimated differences for both short and long interpregnancy intervals. There are nonetheless study limitations. The clinical impact of a few months difference in interpregnancy intervals is unknown, although effects at the population level may be significant. The results suggest that a change of only 1 month in the interpregnancy intervals of the Anglophone population could have a beneficial impact on maternal-infant health. Information on the delivery date for the first pregnancy was self-reported by the mother, and in some cases, may have been incorrectly recorded. Socioeconomic status and language were only available at the second delivery, and we do not know the extent to which these could have differed compared with the first birth. We could not adjust for maternal age, and cannot rule out residual confounding due to differences in maternal age between linguistic groups. We could not study bilingual or other language groups due to sample size limitations, or account for material deprivation as an area-level variable in a multilevel analysis. This study was limited by measures of socioeconomic status that were imperfect. We did not have information on household income, or any measure of socioeconomic status of the partner, and area deprivation is an ecological marker that may not reflect individual deprivation. We did not have information on abortion, immigration period, family planning,

breastfeeding, contraception, or other characteristics potentially related to interpregnancy intervals.^{5,6,22,23} Finally, Quebec is a multicultural population where language does not necessarily reflect ethnicity, hence the results cannot be inferred to ethnic subgroups.

Conclusion

This study found evidence of differences in interpregnancy intervals between Anglophones and Francophones of Quebec. Disadvantaged minority Anglophones had unfavourable interpregnancy intervals compared with disadvantaged Francophones. These findings suggest that linguistic differences in interpregnancy intervals may be present in Canada, and add to the growing evidence that socioeconomically disadvantaged Anglophones may be a vulnerable population in Quebec.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contributions and statement

NA conceived and designed the study, and LL and MBB performed the statistical analysis with guidance from NA. ADB and AC helped interpret the results. NA, MBB and ADB drafted the manuscript, and LL and AC revised it for critical intellectual content. All authors approved the final version submitted.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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Commentary

The case for more comprehensive data on household food insecurity

Valerie Tarasuk, PhD; Timmie Li, BSc; Andrew Mitchell, MA; Naomi Dachner, MSc

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Introduction

Household food insecurity refers to the inadequate or insecure access to sufficient food because of financial constraints. The inclusion of questions related to food insecurity on national population health surveys over the past two decades has yielded a solid understanding of the social epidemiology of food insecurity in Canada and established it as an indicator of nutrition inequity and a potent social determinant of health. There is also growing recognition that problems of household food insecurity cannot be managed by community responses. Policy interventions are required to address the conditions underpinning this vulnerability. Awareness of the importance of food insecurity has heightened the demand for information about the extent of this problem.

It is increasingly common for food insecurity statistics to be included in status reports on the health and well-being of the population at the provincial, municipal, and regional levels. Such reporting is important in enabling policymakers, social planning agencies, public health authorities, and other stakeholders to gauge the extent of deprivation in their communities, monitor the impact of changing social and economic conditions on prevalence, and set priorities for interventions. However, the limited quality of publicly available data on household food insecurity impedes such data usage efforts. The purpose of this commentary is to provide an overview of the monitoring of household food insecurity in Canada, describe the statistics on household food insecurity of most relevance to population health, and identify critical gaps in the current reporting of the prevalence of food insecurity.

Food insecurity measurement in Canada

Questions about child hunger and household food insufficiency began to appear on national population health surveys in 1994, but systematic assessment of household food insecurity did not begin until 2004 when the Household Food Security Survey Module (HFSSM), a standardized, validated, 18-item scale of severity developed by the U.S. Department of Agriculture, was added to Cycle 2.2 of the Canadian Community Health Survey (CCHS).¹ The HFSSM is designed to characterize the level of food insecurity in the household overall. The questions capture experiences of food insecurity ranging from concerns about running out of food before there is more money to buy more, to the inability to afford a balanced diet, to going hungry, missing meals, and in extreme cases, not eating for a whole day because of a lack of food and money for food. Ten questions refer to household conditions generally and adults' experiences in particular, and for households that include members under 18 years of age, an additional eight questions are asked to assess the children's experiences of food insecurity.

Health Canada undertook an extensive examination of the survey results from CCHS 2.2 to confirm the appropriateness of the HFSSM for food insecurity assessment in Canada.¹ They also developed a classification scheme to define moderate and severe food insecurity¹ and proposed classifying any household with zero or one affirmative response on either the adult or child-referenced scale as food secure. Since that time, a substantial body of research has emerged, indicating that even a single affirmative response on the

Highlights

- As awareness of the population health importance of household food insecurity and its relation to public policy decisions grows, interest in food insecurity statistics is burgeoning at the provincial, municipal, and regional levels.
- The publicly available data on its prevalence are insufficient to support stakeholders' interests and needs for timely, locally relevant information.
- Several jurisdictions fail to measure food insecurity when its inclusion on the Canadian Community Health Survey is optional.
- We recommend mandatory measurement annually, with routine reporting of the total number of persons living in food insecure households and marginal food insecurity counted as part of food insecurity.

HFSSM denotes significant vulnerability, with important consequences for individuals' health and well-being. These findings make a strong case for treating marginally food insecure households as a discrete group and including them in estimates of the population prevalence of household food insecurity, but to date Health Canada's classification scheme has not been revised. Because this scheme defines the reporting practices of Statistics Canada and most provincial and regional authorities, updating it to reflect current science will improve food insecurity assessment nationally.

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Monitoring the prevalence of household food insecurity

Food insecurity is monitored on the annual cycles of CCHS. The survey sample is designed to be representative of 98% of the Canadian population aged 12 and over, omitting individuals on First Nation reserves, in institutions, in the Canadian Armed forces, and in some remote areas. The application of household weights, developed by Statistics Canada to account for the sampling design and patterns of nonresponse, yields a population-representative sample of Canadian households for each survey year, enabling estimation of the proportion and number of households who reported food insecurity over that year. While these weights can be used to generate national and provincial/territorial prevalence estimates, they have not been calibrated for use at sub-provincial/territorial levels, limiting the determination of food insecurity prevalence at the regional or community level.

The national prevalence of food insecurity in 2007-08 and 2011-12, the two cycles for which nationally representative data are available, is presented in Table 1. Irrespective of whether marginally food insecure households are counted as food insecure, the prevalence has risen significantly over this period. Given the abundance of evidence that food insecurity is detrimental to health, this increase should be cause for serious concern.

Estimating the number of individuals living in food insecure households

In addition to tracking the household prevalence, it is critical to track the number of people exposed to household food insecurity because this exposure is a highly significant predictor of individuals' health and well-being. Tracking the number or proportion of people (versus households) affected by food insecurity is also consistent with the way in which other population statistics are reported (e.g. the rate of child poverty, the unemployment rate, the number of people using food banks), and perhaps because of this, it appears to be the preferred metric for reporting on household food insecurity in lay publications and the status reports issued by various social planning agencies, public health authorities, and other stakeholders groups. Accessing such information is complicated, however, because the

CCHS sample only comprises persons aged 12 and over.

Through the application of person weights, population-representative estimates of the number of individuals 12 years of age and older living in food insecure households can easily be derived from CCHS data, but this seriously understates the total number of persons affected and renders invisible the heightened vulnerability of younger children to household food insecurity. The total number of persons living in food insecure households can be estimated by applying household weights to the data on household composition in CCHS. Using this approach, we find that 3 939 500 Canadians lived in food insecure households in 2011-12; that is 529 300 more than the number in 2007-08 (Table 1). Moreover, one in five people living in a food insecure household in these years was a child under 12 years of age.

The variables required to estimate household prevalence and the total number of

persons living in food insecure households are contained in the CCHS Master Files available to researchers in the Statistics Canada Research Data Centres and the Share Files available to the provincial and territorial governments, but they are not available in the public use files for CCHS. Thus, this information is inaccessible to agencies and organizations without the capacity and authorization to analyze the CCHS microdata.

The frequency of food insecurity measurement

The HFSSM has been included as core content on the 2007-08, 2011-12, and 2017-18 cycles of CCHS, but in the intervening years, the decision to administer the module has rested with the provincial and territorial governments. Only Alberta, Quebec, Nova Scotia, Northwest Territories, and Nunavut have elected to measure household food insecurity on every cycle since the HFSSM was introduced in 2005. Yet, food insecurity prevalence rates across Canada are not static, as indicated by the significant increase in prevalence nationally

TABLE 1
Number and proportion of households reporting food insecurity and number of people living in food insecure households in Canada, 2007-08 and 2011-12

	2007-08	2011-12
All households		
Marginal food insecurity	446 000 (3.6%)	536 200 (4.1%)
Moderate food insecurity	626 300 (5.1%)	759 600 (5.8%)
Severe food insecurity	329 500 (2.7%)	333 500 (2.5%)
Total	1 401 800 (11.3%)*	1 629 400 (12.4%)*
All persons		
Marginal food insecurity	1 155 100	1 389 800
Moderate food insecurity	1 570 800	1 897 600
Severe food insecurity	684 200	652 000
Total	3 410 200	3 939 500
All persons, 12 years and older		
Marginal food insecurity	932 700	1 107 100
Moderate food insecurity	1 237 200	1 518 700
Severe food insecurity	556 300	537 300
Total	2 726 300	3 163 000
All persons, under 12 years		
Marginal food insecurity	222 400	282 800
Moderate food insecurity	333 500	378 900
Severe food insecurity	127 900	114 800
Total	683 800	776 500

Note: Totals may not add up due to rounding.

* Chi-square test of proportions indicates significant difference, $p < 0.0001$. When marginal food insecurity is omitted from the total prevalence of food insecurity, the chi-square test of difference between cycles is significant at $p = 0.0017$.

between 2007-08 and 2011-12. Food insecurity rates vary in response to changes in macroeconomic conditions^{2,3} and policy decisions that impact household finances.^{3,6}

Provincial and territorial governments' decisions to opt out of food insecurity measurement impede the use of data by policymakers, public health authorities, and other stakeholders within these jurisdictions to assess the extent of deprivation in their areas and set evidence-based priorities for program and policy responses. Gaps in measurement also thwart research and evaluation activities to identify the effects of specific policy decisions on food insecurity prevalence and severity. Only by being able to compare prevalence rates before and after particular policy reforms have we come to understand the power of federal and provincial policy decisions to impact this problem.^{3,6} Without pre- and post-intervention data, how can we possibly evolve our understanding of 'what works'? The sporadic measurement of food insecurity is retarding the development of the knowledge needed to devise evidence-based policy responses to a serious, widespread and growing population health problem.

The availability of information on food insecurity prevalence

CANSIM tables provide online access to estimates of the prevalence of moderate and severe household food insecurity combined⁷ and the prevalence of individuals 12 years of age and older living in moderately or severely food insecure households for 2007-08 and 2011-12.⁸ These estimates are available at the national, provincial, and territorial level, with sub-provincial estimates available for the person-weighted calculations of exposure of individuals aged 12 and older. Health Canada has posted summary statistics on moderate and severe food insecurity in the provinces and territories that participated in measurement in 2005 and 2009-10, and in August 2017, they posted charts including provincial and territorial prevalence estimates for 2013-14.

Some provincial and territorial governments and some local health authorities have published reports on food insecurity rates for their jurisdictions for years other than those covered by CANSIM, but this reporting typically mirrors Statistics Canada's CANSIM releases. With very few

exceptions, rates of moderate and severe food insecurity have been combined, marginally food insecure households have been counted as food secure, and individual exposure has only been reported for people 12 years of age and older. Additionally, it is not clear that any jurisdiction has committed to the regular, timely reporting of food insecurity statistics.

As part of the knowledge translation strategy of our CIHR-funded research program, 'PROOF', we produced more comprehensive reports on household food insecurity prevalence in Canada in 2011, 2012, 2013, and 2014, e.g. ⁹. The overwhelming interest in these reports suggests that they have filled an important void for stakeholders and the public at large. However, knowledge translation work undertaken as part of a time-limited research initiative cannot substitute for the regular, timely release of statistics on food insecurity on government websites.

Conclusions and recommendations

As knowledge of the health and social consequences of household food insecurity in Canada grows and the intersections of this problem with public policy decisions become better understood, the importance of food insecurity monitoring is becoming more evident. The only nationally representative measures we have indicate a substantial increase in the number of Canadians living in food insecure households between 2007-08 and 2011-12, highlighting the need for even more vigilance in the tracking of this problem going forward.

Understanding the scale of household food insecurity in our population hinges on tracking the proportion of households who are food insecure and the number of individuals living in food insecure households. Yet, the public reporting of exposure is currently limited to the number of individuals over the age of 12 who live in moderately and severely food insecure households, no information is available on the prevalence of food insecure households at the regional or municipal level, and marginally food insecure households continue to be treated as if they were food secure. Moreover, the treatment of food insecurity measurement as optional content on most cycles of CCHS precludes the use of evidence to inform actions in

jurisdictions that choose not to measure the problem and impedes the research necessary to develop effective responses to food insecurity nationally and at the provincial/territorial level.

To address the limitations in data collection and reporting identified here, we recommend that

- i. the routine reporting of food insecurity statistics in CANSIM tables be updated to include information on the total number of persons living in food insecure households;
- ii. marginal food insecurity be recognized as food insecurity and included in calculations of prevalence;
- iii. where possible, household weights for CCHS be calibrated at sub-provincial/territorial levels so that more local level data on food insecurity can be made available; and
- iv. the assessment of household food insecurity become core content on all cycles of CCHS.

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Conflicts of interest

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Statement

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At-a-glance

Perceptions of caffeinated drinks among youth and young adults in Canada

Brittany Cormier, BA; Jessica L. Reid, MSc; David Hammond, PhD

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Abstract

The current study assessed youth and young adults' perceptions and attitudes toward caffeine and energy drinks (EDs). An online survey was conducted with 2036 panelists aged 12–24, about caffeine and ED knowledge, caffeine perceptions, and perceptions of ED safety. Few respondents (2.1%) could state Health Canada's recommended limit for caffeine intake, although most participants (64.9%) correctly stated the maximum number of EDs that should be consumed per day. When shown four beverages, only 17.5% correctly identified the beverage with the most caffeine. Overall, young people generally have low levels of knowledge about caffeine amounts and intake from caffeinated beverages.

Keywords: caffeine, energy drinks, perceptions, attitudes, adolescents

Introduction

When consumed in moderation by adults, caffeine is generally safe.¹ However, there are growing concerns regarding the health effects of caffeine consumption among young people. Caffeine has been linked to altered sleep patterns, increased sugar consumption, and mental health problems among young people, and there are concerns about the effects of caffeine consumption during the period of active brain development.^{2,6}

According to Health Canada, adolescents older than 12 years should consume no more than 2.5 mg/kg in body weight of caffeine daily.¹ Canadian data on young people's caffeine consumption is limited,⁷ although US data from 2009–2010 suggested that 71% of respondents aged 2–19 consumed caffeine on a given day, and at least 10% of caffeine consumers aged 12–19 ingested more than 2.45 mg/kg per day.⁸

The caffeinated beverage market continues to expand with new products, such as energy drinks (EDs) and energy shots,

several of which are targeted to young people.⁹ Previous studies suggested that many young people were unaware of caffeine amounts or daily intake recommendations, often confused caffeinated and non-caffeinated beverages (such as sports drinks), and had mixed perceptions of ED safety.^{10–13} This study examined knowledge of maximum daily intake recommendations for caffeine and EDs, knowledge of relative amounts of caffeine in beverages, and perceptions of caffeine's effects and ED safety.

Methods

Data were collected via self-completed, web-based surveys conducted in 2015 among 2036 Canadians.

The study was reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE #19401).

Measures

Additional description and specific wording of all measures are publicly available.¹⁴

Highlights

- Young people generally had low levels of knowledge about specific caffeine intake recommendations, with a large majority of respondents unable to report the recommended maximum daily intake for caffeine.
- Young people tended to have somewhat higher levels of knowledge regarding energy drink intake recommendations and ingredients than specific caffeine intake recommendations.
- More than a third of young people reported that caffeine could help them play sports and lose weight, and felt that it was safe to use energy drinks while being physically active.

Caffeine knowledge and perceptions

Participants were asked whether they knew the maximum daily intake for caffeine recommended by Health Canada for someone their age and, if so, to enter the number of milligrams. Respondents were also shown images of four beverages (473mL Monster ED, large Tim Horton's coffee, 591mL Coca-Cola, and 591mL Gatorade) and asked to select the one with the most caffeine. Perceptions of caffeine's effects were assessed using agreement with seven statements (Table 1). Responses were coded numerically from 1 (strongly disagree) to 5 (strongly agree) and summed to create an index of caffeine's perceived positive effects.

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Energy drink knowledge and perceptions
Respondents were shown an image of an ED can (473mL) and were asked: "What is the maximum number of cans of this product someone your age should have in one day?". Respondents were also asked to identify the "...main ingredient(s) in energy drinks that give the energy boost?",

and whether the "main ingredients" in sports drinks were the same ingredients that give the energy boost in EDs. In addition, respondents were asked whether they perceived EDs to be good or bad for their health. Lastly, eight items assessed perceived addictiveness of caffeine and perceived safety of energy drinks (Table 1).

Responses were coded numerically from 1 (definitely not safe) to 5 (definitely safe) and summed to create an index of perceived ED safety. For both the effects and safety indices, "don't know" responses were recoded as "in the middle" to avoid exclusion from the index; missing responses were excluded. Items were reverse coded when appropriate.

TABLE 1
Perceived caffeine effects and perceptions of energy drink safety among youth and young adults

Effects	Strongly disagree, % (n)	Disagree, % (n)	In the middle, % (n)	Agree, % (n)	Strongly agree, % (n)	Don't know, % (n)
Caffeine makes me feel anxious. (n = 2033)	10.6% (216)	23.6% (479)	26.1% (530)	20.4% (414)	4.9% (100)	14.4% (294)
I like the way caffeine makes me feel. (n = 2032)	7.3% (149)	12.9% (262)	38.7% (786)	23.6% (479)	5.0% (102)	12.5% (254)
Caffeine makes it hard for me to sleep at night. (n = 2034)	6.8% (139)	13.8% (281)	18.7% (380)	34.1% (694)	15.6% (318)	10.9% (222)
Caffeine can help me study. (n = 2035)	8.3% (169)	13.7% (279)	21.6% (440)	37.8% (769)	9.2% (188)	9.3% (190)
Caffeine helps me to play sports. (n = 2035)	18.7% (381)	28.1% (571)	25.9% (527)	13.6% (277)	2.0% (41)	11.7% (238)
Caffeine can help me lose weight or help keep weight off. (n = 2034)	20.0% (407)	28.3% (575)	23.4% (476)	8.0% (164)	1.8% (37)	18.5% (375)
Caffeine is addictive.* (n = 2035)	4.3% (88)	8.0% (164)	14.7% (299)	46.8% (952)	19.6% (399)	6.6% (134)
Is it safe...	Definitely not, % (n)	Probably not, % (n)	In the middle, % (n)	Probably, % (n)	Definitely, % (n)	Don't know, % (n)
...for you to use energy drinks? (n = 2035)	20.6% (419)	35.6% (725)	24.1% (490)	14.9% (304)	1.5% (30)	3.4% (68)
...for children to use energy drinks? (n = 2035)	66.2% (1347)	23.3% (475)	5.0% (102)	2.5% (52)	0.6% (13)	2.3% (47)
...for pregnant/breastfeeding women to use energy drinks? (n = 2034)	65.9% (1340)	24.2% (492)	2.5% (51)	1.2% (24)	0.9% (17)	5.4% (109)
...to mix alcohol with energy drinks? (n = 2034)	52.8% (1074)	30.2% (614)	7.2% (146)	3.9% (79)	1.0% (21)	5.0% (101)
...to use energy drinks while working out or playing sports? (n = 2035)	22.0% (447)	32.2% (654)	21.8% (443)	15.6% (317)	1.7% (34)	6.9% (140)
...to use energy drinks to help you study? (n = 2035)	17.4% (353)	27.5% (559)	29.0% (590)	16.6% (338)	3.1% (64)	6.4% (131)
...for people your age to drink more than the daily maximum number of cans/bottles printed on the container? (n = 2034)	54.0% (1098)	31.1% (632)	7.1% (144)	3.7% (75)	1.0% (19)	3.2% (66)

* Item is part of the safety index.

Statistical analysis

Analyses included descriptive statistics, as well as linear regression analyses with pairwise model selections examining sociodemographic correlates of perceived caffeine effects and perceived ED safety indices [$\hat{Y} = B_0 + \text{gender}(x) + \text{age}(x) + \text{language}(x) + \text{region}(x) + \text{ethnicity}(x) + \Sigma$]. The Bonferroni correction was applied to all p levels to adjust for multiple pairwise comparisons. Post-stratification sample weights were constructed and applied to the dataset. Estimates reported in text are weighted unless otherwise specified. All analyses were conducted using IBM SPSS Statistics 24.

Results

Sample characteristics

Demographic characteristics of the sample are reported elsewhere.¹⁴ Respondents were between the ages of 12-24, residents of Canada (excluding the territories), and the majority were White (67.0%, unweighted) and English-speaking (78.1%, unweighted).

Caffeine knowledge

Overall, 5.1% of respondents ($n = 104$) reported knowing the maximum daily intake for caffeine recommended by Health Canada for their age, while 94.9% ($n = 1928$) responded with "no" or "don't know". However, not all who reported knowing the maximum daily intake provided a correct response when prompted: only 2.1% ($n = 42$) of the 2036 respondents could correctly state the maximum daily intake for caffeine. When shown four beverages, and asked to select the one with the most caffeine, most respondents selected the ED (60.5%, $n = 1231$), while only 17.5% ($n = 355$) correctly identified coffee as having the most caffeine. Fewer respondents selected Coca-Cola (13.9%; $n = 283$) or Gatorade (0.8%; $n = 17$), and 7.3% ($n = 147$) selected "don't know".

Caffeine effects

As shown in Table 1, most respondents chose "in the middle" when asked to rate their agreement with "Caffeine makes me feel anxious" and "I like the way caffeine makes me feel". Most respondents agreed that caffeine could help them study and made it hard to sleep at night, while most disagreed that caffeine could help them lose weight or play sports. Most respondents agreed that caffeine was addictive.

Table 2 displays the results of separate linear regression models examining sociodemographic correlates of indices of perceived caffeine effects and perceived ED safety. Sex and age were significantly associated with index scores for perceived caffeine effects. Specifically, respondents who were male and older scored higher, indicating that these groups perceived caffeine's effects more positively.

Energy drink knowledge

When shown an image of an ED and asked the maximum number of cans someone their age should consume in one day, most respondents (64.9%, $n = 1318$) correctly stated "one" or fewer, while 18.7% ($n = 380$) responded incorrectly (> 1), and 16.3% ($n = 331$) did not know.

When respondents were asked to state the main ingredients in energy drinks that give the energy boost, caffeine was reported most frequently (41.1%, $n = 836$), followed by sugar (12.8%, $n = 260$), taurine (10.6%, $n = 216$), guarana (3.5%, $n = 70$), vitamins (3.3%, $n = 66$), ginseng (3.1%, $n = 64$) and other ingredients (1.1%, $n = 22$). Most respondents (63.2%, $n = 1286$) correctly believed that the main ingredients in sports drinks were not the same ingredients that give the energy boost in EDs, although 7.5% ($n = 153$) believed they were the same and a substantial proportion (29.3%, $n = 596$) did not know.

Perceptions of energy drinks

Three-quarters of respondents thought that EDs were bad for your health: 46.6% ($n = 950$) selected "Bad for your health" and 29.6% ($n = 603$) selected "Very bad...". Very few said, "Good for your health" (2.4%, $n = 49$) or "Very good..." (0.5%, $n = 11$), while 17.9% ($n = 364$) said "Neither good nor bad", and 2.9% ($n = 60$) did not know.

Perceived energy drink safety

Table 1 presents responses to items regarding ED safety. Most respondents indicated it was "definitely not" or "probably not" safe for themselves to use EDs, or to use EDs while working out or playing sports. Most respondents also indicated it was "definitely not" safe for children or pregnant/breastfeeding women to use EDs, to mix EDs with alcohol, or to consume more than the daily maximum number of cans/bottles printed on the container.

Sex, age, language, ethnicity, and region were all significantly associated with scores on the index of perceived ED safety (Table 2). Specifically, respondents who were male, aged 12-14 (vs. 18-20), English-speaking, and of other/mixed race/ethnicity scored higher, demonstrating that these groups perceived EDs as safer. Residents of Atlantic Canada had lower scores, demonstrating that they perceived EDs as less safe.

Discussion

Young people generally have low levels of knowledge about specific caffeine intake recommendations, with most respondents unable to report the recommended maximum daily intake. Although Health Canada has established recommendations,¹ few efforts have been undertaken to communicate these guidelines to consumers. In addition, recommendations are presented in mg/kg of body weight for adolescents, which may be too complex and cause misunderstandings.

Young people had somewhat higher levels of knowledge regarding ED intake recommendations and ingredients. Health Canada requires that EDs display a cautionary statement on the packaging¹⁵ presented as maximum number of containers, which is an easy-to-understand unit and may help explain the knowledge difference between caffeine in general and EDs specifically. Despite higher levels of knowledge for recommended maximum ED consumption compared to caffeine, one-third of respondents did not know, or gave an incorrect number for, the recommended limit for ED consumption.

Lastly, the study found that over one-third of young people reported that caffeine can help them play sports or lose weight, and felt it safe to use EDs while physically active. This is of particular concern as caffeine consumption is not recommended by Health Canada during intense physical activity, due to an increased risk of adverse events.¹³

Limitations

Limitations to the study include response biases such as social desirability, and a lack of probability-based recruitment methods; however, post-stratification weights were used to ensure representative distributions of demographic variables.

TABLE 2
Estimates from the linear regression models for indices of perceived caffeine effects and energy drink safety

Characteristic	Perceived caffeine effects (n = 1757)			Perceived energy drink safety (n = 1758)		
	<i>p</i>	Beta (95% CI)	<i>p</i> ^a	<i>p</i>	Beta (95% CI)	<i>p</i> ^a
Intercept	<i>p</i> < 0.001	16.74 (15.64, 17.85)		<i>p</i> < 0.001	14.43 (12.74, 16.11)	
Sex	<i>p</i> < 0.001			<i>p</i> < 0.001		
Female (ref) vs. Male		0.55 (0.28, 0.81)	< 0.001		1.57 (1.17, 1.97)	< 0.001
Age group	<i>p</i> < 0.001			<i>p</i> = 0.07		
12-14 (ref) vs. 15-17		0.89 (0.51, 1.28)	< 0.001		-0.25 (-0.84, 0.34)	1.00
12-14 (ref) vs. 18-20		1.12 (0.71, 1.53)	< 0.001		-0.96 (-1.58, -0.34)	0.02
12-14 (ref) vs. 21-24		1.34 (0.96, 1.72)	< 0.001		-0.49 (-1.07, 0.09)	0.60
15-17 (ref) vs. 18-20		0.23 (-0.14, 0.60)	1.00		-0.71 (-1.28, -0.14)	0.09
15-17 (ref) vs. 21-24		0.45 (0.10, 0.79)	0.07		-0.24 (-0.76, 0.29)	1.00
18-20 (ref) vs. 21-24		0.22 (-0.15, 0.59)	1.00		0.47 (-0.09, 1.03)	0.59
Language of survey	<i>p</i> = 0.12			<i>p</i> = 0.02		
English (ref) vs. French		—	—		-1.19 (-2.18, -0.21)	0.02
Race/Ethnicity	<i>p</i> = 0.04			<i>p</i> < 0.001		
White (ref) vs. mixed/other		0.28 (-0.03, 0.60)	0.23		1.56 (1.08, 2.04)	< 0.001
White (ref) vs. Aboriginal		-0.57 (-1.29, 0.15)	0.36		0.14 (-0.96, 1.23)	1.00
Mixed/other (ref) vs. Aboriginal		-0.85 (-1.59, -0.11)	0.07		-1.42 (-2.56, -0.29)	0.04
Region of residence	<i>p</i> = 0.97			<i>p</i> = 0.01		
BC (ref) vs. PR		—	—		-0.32 (-1.06, 0.43)	1.00
BC (ref) vs. ON		—	—		-0.06 (-0.70, 0.58)	1.00
BC (ref) vs. QC		—	—		-1.01 (-2.13, 0.10)	0.75
BC (ref) vs. ATL		—	—		-1.51 (-2.50, -0.52)	0.03
PR (ref) vs. ON		—	—		0.26 (-0.34, 0.86)	1.00
PR (ref) vs. QC		—	—		-0.70 (-1.77, 0.38)	1.00
PR (ref) vs. ATL		—	—		-1.19 (-2.14, -0.25)	0.13
ON (ref) vs. QC		—	—		-0.95 (-1.96, 0.05)	0.62
ON (ref) vs. ATL		—	—		-1.45 (-2.33, -0.57)	0.01
QC (ref) vs. ATL		—	—		-0.50 (-1.72, 0.72)	1.00

Abbreviations: ATL, Atlantic (New Brunswick, Newfoundland & Labrador, Nova Scotia, Prince Edward Island); BC, British Columbia; CI, confidence interval; ON, Ontario; QC, Quebec; PR, Prairies (Alberta, Manitoba, Saskatchewan).

^a All *p*-values adjusted using Bonferroni correction

— : Not applicable.

Conclusion

Our findings suggest that among young Canadians, males perceive caffeine effects more positively and EDs as safer, and younger adolescents and those of other/mixed race/ethnicity view EDs as safer. Future research should explore methods to increase young people's knowledge of caffeine and ED recommendations and risks, particularly for those groups who view EDs as safe. Given market trends, additional research should also examine the use of caffeinated products during physical activity, and monitor caffeine intake among young people.

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Conflicts of interest

There are no conflicts of interest to report.

Authors' contributions and statement

D.H. and J.L.R. were involved in the study design and data collection. All authors (B.C., J.L.R., and D.H.) were involved in data analysis and manuscript preparation, including drafting and revisions.

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The Health and Social Dimensions of Adult Skills in Canada

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